THE WATER QUESTION.

A LETTER,

ADDRESSED (BY PERMISSION) TO

THE RT. HON. THE EARL OF DERBY, K.G.,

EXPLAINING

A PROPOSAL FOR THE SUPPLY OF THE METROPOLIS FROM THE HIGHER SOURCES OF THE THAMES IN CONJUNCTION WITH THE STORAGE OF SURPLUS WATERS.

BY

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TO

THE RIGHT HON. THE EARL OF DERBY, K.G.,

&c. &c.

It is with some satisfaction that I take advantage of your Lordship's permission to place before you my views on a subject which is now acknowledged to be of the greatest social importance. I refer to the Supply of Water, not to the metropolis only, but to the country generally, with which is essentially and inseparably connected the drainage of lands and towns. It is, in fact, the want of a full appreciation of the service and functions of rivers, particularly in their two distinctive characters of outfall drains of their water sheds and sources of water supply, that has led to much of the evil under which we are now suffering. I hope I shall not be considered dogmatical in asserting that this view of the matter is signally proved by two legislative proceedings of very recent date. I allude, first, to the appointment of a commission (the Rivers Commission), dated the 18th May, 1865, "for the purpose of inquiring how far the present use "of rivers or running waters in England, for the purpose of "carrying off the sewage of towns and populous places and the "refuse arising from industrial processes and manufactures, *can* "*be prevented* without risk to the public health or serious injury "to such processes and manufactures, and how far such sewage "and refuse can be utilized or got rid of *otherwise than by dis-* "*charge into rivers or running waters*, or rendered harmless "before reaching them"; and, next, to the proceedings of the Committee of the House of Commons of last Session on the Thames Navigation Bill, which resulted in a compact between the several water companies of the metropolis and the late Government, who were promoting the Bill, by which all towns on the banks of the river are to be prevented from discharging their sewage into it, and the water companies are, with that understanding, to continue to draw their supplies from the river

on an annual payment of £1,000 each; both the proceedings of the Commission and the arrangement of the Committee being based on the assumption that it is practically possible to "*prevent the pollution*" *of rivers.* My Lord, this is a fallacy that we cannot too soon nor too thoroughly realise. The only way by which the rivers can be maintained in their aboriginal purity, and in a condition fit to drink, is to exclude from them, wholly and completely, contaminating fluids; but, inasmuch as all fluids flow to the lowest place, and rivers occupy the lowest place in all water sheds, with the sea as their ultimate destination, it is obviously impossible to "prevent the use of rivers" for carrying off, in some shape or other, the refuse liquid of the towns and lands within their water sheds. The Rivers Commission, seeing this insurmountable difficulty, adopted the views of a previous Commission "for inquiring into the best mode of distributing the sewage of towns," and recommended that irrigation should be employed, as the best mode of lessening the obnoxious character of refuse fluids before they arrive at their natural destination. They state in their very admirable report, that "all expedients for disposal of town sewage other than by " application to land, seem to us, on one ground or another, " objectionable." They declare that "sewage water, if *passed* " *over a sufficient area of grass land, passes off* * *bright, tasteless,* " *and without smell*"; and add, "that irrigation will be found to " be the mode of dealing with sewage which results in the largest " amount of good to the land, and the smallest amount of harm " to flowing water."

On these conclusions the country is now called upon to act.

Irrigation as a means of purifying rivers.

There is no doubt that of all processes of filtration, that by irrigation is the most effective. It is, however, far from a perfect process; though it has advantages which commend it to the attention of the country. All persons admit that, whatever ingredients are extracted from sewage in its passage over or

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* The terms here used would imply that it is only necessary to run sewage *over* land, and that the Commissioners do not consider natural or artificial under-drainage essential. This appears to be erroneous, and likely to defeat the object in view, for surface vegetation, though it acts as an upturned brush to arrest a large part of the solid, with power to appropriate a part of the soluble matter, is not so effective as a bed of drained soil with a growth of vegetation upon it, through which the sewage can percolate. In such case the whole of the solid and a larger proportion of the soluble matter will be taken up and retained. Indeed, without under-drainage, natural or artificial, irrigation cannot be fully successful.

through the soil, they serve to increase the produce of the land, and thereby to enrich the country. Moreover, it is as generally allowed that towns so disposing of the sewage may fairly expect a return for this enriching refuse. But the desire to turn our waste sewage to profit should not lead us into the fallacy of believing that irrigation will render sewage pure enough to drink. It is on this point we make the greatest mistake. If it be admitted that rivers must continue to receive the drainage of lands irrigated with sewage, we must admit that they will continue polluted, though in a mitigated form—*i.e.*, with clarified sewage, instead of simple sewage. It would appear to be acknowledged by the best chemists, that when once the soluble organic matters and gases of sewage become diffused through a volume of water, it is practically as difficult to extract them as it would be to recover the fumes of a dung heap as they rise and pervade the air above our heads. Irrigation certainly fails to do it, and can only be regarded as a better means of clarifying sewage than filtration through artificial porous beds in which vegetation takes no part. If this be true, the compact entered into between the Committee of the House of Commons last Session, on the one part, and the Water Companies of the metropolis on the other, can only serve to perpetuate a mitigated evil so long as Oxford, Abingdon, Reading, Windsor, and other river-side towns discharge their sewage, or the drainage of their irrigated lands, into the Thames. To excuse the mixture of sewage, after it has done service in irrigation, with river water, and the supply of such diluted sewage as water for domestic purposes, we are obliged to rest upon the theory of oxydation which is very far from satisfactory. Upon these several points I beg to bring under your Lordship's attention the present opinion of some of our leading chemical and medical authorities who are fully informed upon the subject. (*See* Appendix.)

Sir Benjamin Brodie, the Professor of Chemistry in the University of Oxford, in his evidence before the Rivers Commission, in answer to the direct question, put by Professor Way, "Do you apprehend that if sewage was applied to a sufficient "area of land the liquid running off would be equally "likely to foul the river?" said, "Speaking not from my own "experience, but from such information as I possess, I should "say that it undoubtedly would not be equally likely. I do not "think that it could be asserted that all injurious matter was "removed from the water by placing it on the land, but certainly "it must be very much diminished; there is very much more "chance of getting rid of it by that means than by throwing the

"sewage into the river. With regard to the oxydation, we "know that to destroy organic matter the most powerful oxy-"dizing agents are required; we must boil it with nitric acid and "chloric acid and the most perfect chemical agents. To think to "get rid of the organic matter by exposure to the air for a short "time is absurd; when once the matter was brought into a liquid "condition on to the land, the oxydizing action would be much "more rapid upon it, because there would be a very much larger "surface exposed to the action."

Dr. Voelcker, the Consulting Chemist of the Royal Agricultural Society, in a letter with which he has favoured me (*see* Appendix), whilst concurring in the opinion "that the soil is the "most efficacious of all practically available means of rendering "offensive matters harmless and converting them into the food "of plants," states that he "has repeatedly analysed the clarified "water of sewage after it has undergone the *purifying* influence "of irrigation, and in the majority of instances has found such "purified water, though clear and free from smell, almost as "unfit for drinking, cooking, and washing purposes, as it was in "its original filthy condition." "Many people," he adds, "call "water pure when it is clear and no smell perceptible, forgetting "all the while that the greater proportion of the soluble alkaline "medicinal salts, together with the products of oxydation of the "nitrogenous constituents of fœces and urine cannot be removed "by filtration through any amount of soil."

Dr. Odling states also that, "according to our present "knowledge, it is practically impossible, by any artificial "process, to render large bodies of sewage or contaminated "water pure enough to be available for drinking purposes." (*See* Appendix.)

Dr. Letheby, the Medical Officer of Health for the City of London, on the other hand, puts the matter somewhat differently. In reply to the question I ventured to ask him, "whether any "mode of irrigation, filtration, precipitation, or other process, "suggested by science, can make sewage water fit to drink," or "whether river water into which irrigated lands discharge their "refuse, can properly be used for the same purpose," he says, "if, "therefore, you put it to me whether the worst kind of sewage "can be so dealt with by any reasonably practical means, and be "made at once fit for drinking purposes, I have no hesitation in "saying that it cannot; but I can, on the other hand, say in "quite as positive terms, that ordinary sewage can be so dealt "with as to be rendered perfectly inert, and the flow of such "defœcated sewage into rivers is altogether harmless," and "that

" when it is mixed with not less than twenty times its volume of " good water in a river, and has had a run of eight or ten miles, " it is not merely harmless but is actually destroyed, and the " water is fit for domestic use." (*See* Appendix.)

Dr. Fuller, however, says on this last point, that " the effect " of running water in oxydizing or otherwise destroying organic " matter is very remarkable, but there are no reliable data on " which to base an opinion as to the length of run which the " water requires before its organic contents are resolved into their " elements, nor even as to whether certain living organic matters " —such as there are good grounds for supposing the cholera " germ to be—are ever destroyed or rendered innocuous by this " agency. There is evidence, however, to prove that a course of " some miles will not suffice to effect this object, and it is " probable that in ordinary slow running streams like the " Thames, many sporules and ova may retain their vitality almost " indefinitely." (*See* Appendix.)

To these medical opinions I am able to add my own experience in two well known cases which have been before our Law Courts. I refer to the cases of " Barnard *v.* Arkwright," and " Goldsmid *v.* The Commissioners of the Town of Tunbridge Wells." In the former case I was called upon by the court to report whether the discharge of the Defendant's sewage into Harlow Brook after filtration and irrigation was pure, when I found that although the liquid was perfectly clear to the eye, it was essentially as foul as ever. In the latter case it was found that although irrigation reduced the nuisance, it failed to make the sewage even clear, and that at a certain period of the year when the process of irrigation was necessarily stopped for hay harvest, the whole evil reverted.* I could multiply positive proofs of the impossibility of rendering polluted water pure, but the opinions and facts I have quoted will be deemed sufficient.

The modified views expressed by Dr. Letheby, will doubtless have a practical influence in the present unsettled state of the public mind, but they really serve to give even greater force to the main conclusion—that no process can render sewage available for drinking purposes—for if it be granted that by very copious dilution sewage may be rendered harmless, it must be implied that, failing the requisite amount of dilution, the reverse is the case, and no one for a moment can doubt, that on few rivers can

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* See also the evidence of Mr. Gurney and Mr. Reynolds, with respect to the Croydon sewage, given before the Rivers Commission.

we depend on having twenty times as much pure water as there will be sewage discharged into them, or that the sewage can have a free run of eight or ten miles before it meets with an additional influx of sewage. The Thames and the Lea both furnish proofs of this, and in the populous districts of the north of England, the difficulty of carrying out Dr. Letheby's views will be equally great.

Under any circumstances much disappointment must follow the adoption of irrigation while the present anticipations prevail.

It is doubtless our duty, not only to utilize to the greatest possible extent the sewage of towns before it enters the rivers, but to render it, when it reaches them, free from objection to the eye and the nose, and though we fail to make it fit to drink, we may certainly, in most cases, accomplish this by irrigation. But those who are practically acquainted with land and the working of irrigation, know that unless the soil is of a very free character, with a quick natural drainage, or being more retentive is closely underdrained, there are times when the land becomes saturated to the surface, and when any additional liquid poured upon it will flow over the surface into the nearest ditches, and by them be conducted into the rivers in an unchanged condition. They know too, that when drained land has absorbed water highly charged with manurial matter, up to its full capability of absorption, the surplus is forced out from beneath during the non-vegetating season of winter, by any fresh accession of fluid from above, carrying with it those ingredients which deny to it even the character of "clarified sewage." I say nothing of the great difficulty of irrigating all the year round—in winter when vegetation is dormant, and in summer when grass crops gain maturity; all these practical objections, however, go far to satisfy practical men, that "the sewage of towns and populous places," cannot "be rendered harmless," though it may be made profitable.

The natural régime *of rivers admits of the supply of pure and the discharge of polluted water at the same time.*

Seeing that under no circumstances, can we prevent the influx of refuse fluids into our rivers, and that our highest medical authorities concur in the conclusion, that sewage from infected patients may communicate infection to those who drink river water by which clarified sewage has been "greatly diluted," ought we not rather to prize the advantage which we possess in

having the rivers as drains to carry it off to the sea, than defy the sanatory law which forbids the use of the water of rivers for drinking purposes after they have become drains? Instead of straining after such irreconcileable objects as using river water *to dilute sewage in order that we may drink it*, why should we not draw the line between the upper portions of our streams which can be maintained in purity and the lower portions of the same, into which the refuse of towns and populous places must in some shape or other enter to be discharged to the sea? These questions are important ones, for they apply not only to this metropolis but to the country generally.

It is not difficult to determine the line of demarcation. *The separating point in the stream is the lowest point at which polluted water can be effectually intercepted.* Above this point the stream would be entirely free from objection for drinking and cooking, and below this point it would receive and carry off the purified sewage, and be serviceable for all other riparian uses than those of actual consumption.

Perhaps of all rivers the Thames, in its upper tributaries, commands the purest and clearest of water; and for some length downwards from the rise of the springs, the streams are remarkably free from organic matter. They exhibit rather a high degree of hardness, *i. e.*, from 14 to 18 degrees before boiling, and a great deal is said on this point, but for drinking and several other domestic purposes, hardness is not an objection.* Moreover, it is much easier to soften hard water than to purify polluted water. (*See* Appendix.) If, therefore, it is a *sine quâ*

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* Some proof of this statement is to be found in the fact that, in the town of Shrewsbury, which has the river Severn running through it, and where the town authorities can command the best water obtainable from the Severn, the water for drinking is supplied from a spring two miles off, which is harder than the Thames water. Mr. Blunt, of Shrewsbury, has favoured me with the following analysis of it, which I print in order that those who lay so much stress on the advantages of the *soft* water of the Severn, and would bring it to the metropolis for *all* purposes, may see that one large town on the river Severn rejects the water of that river for drinking, and has been at the expense of establishing two systems of supply, viz.:—the Conduit (hard spring) water for drinking, and that of the Severn for washing, &c.

Mr. Blunt says—" I have much pleasure in supplying you with a qualitative analysis " of the water supplied by the conduits in this town (Shrewsbury). Temporary degree " of hardness, by Dr. Clarke's scale, 22 degrees; after ebullition, 2° 5′.

" The solid content of an imperial gallon, 23 grains, consisting almost entirely of " carbonate lime, held in solution by free carbonic acid. Chloride sodium, and sulphate " of magnesia are also present in small quantities. Dr. Miller's permanganate test shows " that the water is entirely free from oxydable organic matter."

The pale bitter ale of Burton is made with water of remarkable hardness, and this favourite beverage forms no inconsiderable proportion of the liquid drunk in the metropolis.

non—as every one now admits it to be—that we should have in the metropolis a sufficient supply of perfectly pure water, we have, in the higher portions of the tributaries of the Thames, and in the supplies to be obtained by pumping and from storage, ample means of meeting all possible demands without going beyond the limits of the Thames water-shed. To abstract water from the tributaries without injury to the navigation and mills, and the general service of the river below, proper measures for compensation must be adopted, so as to return to the streams as much water as may be abstracted from them under a certain fixed datum of service height.

I hope to make it manifest that the expense of effecting these combined works will not reach, by some millions, the outlay necessary to bring water from those distant regions which have been so ably proposed by Mr. Bateman, Messrs. Hemans and Hassard, and Mr. Fulton.* But works of a combined character, such as are here suggested, can only be carried out with the aid of a competent body regulating the whole river system of the watershed, such as it is hoped the Thames Conservancy Board will now become.

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* The following short descriptions will explain the main features of these proposals:—

1. To bring from the sources of the Severn in North Wales, by gravitation, one hundred and thirty millions of gallons immediately, and two hundred and twenty millions ultimately, as the daily supply of the Metropolis, and deliver it at Stanmore, 10 miles from London and 250 feet above Trinity high-water mark, which will admit of high and constant service for nearly the whole of the Metropolis.

Length of conduits, 183 miles.

Mr. Bateman's estimate for the works to be constructed, with the aqueduct for the larger supply and reservoirs, &c., for the less (admitting of extension hereafter), including interest of money and all other expenses during construction, is £8,600,000.

2. To bring from the Lakes of Westmoreland and Cumberland, by gravitation, one hundred and fifty millions of gallons daily to the Metropolis, having supplied fifty millions to other towns on the way (making two hundred millions daily), with an intention to increase the quantity hereafter to two hundred and fifty or three hundred millions. The supply will be delivered at Harrow, 12 miles from London and 220 feet above high-water mark.

The length of conduit is not given, but it would probably be between 260 and 270 miles.

Messrs. Hemans & Hassard's estimate for the works for the

Two hundred millions, is	£11,200,000
For the two hundred and fifty millions, is	12,200,000

3. To bring from the sources of the Wye, above Rhayader, in Mid Wales, by gravitation, one hundred and thirty millions of gallons daily, upon completion of the first section of the works, and two hundred and thirty millions ultimately, and deliver it into service reservoirs near Barnet.

The length of the aqueduct is 180 miles.

Mr. Fulton's estimate of the works for the

One hundred and thirty millions, is	£6,877,000
For the two hundred and thirty millions, is	8,877,000

The present consumption of London may be taken at one hundred millions of gallons per diem: about one-half is supplied from the Lea and from chalk springs on the eastern side, and the remainder from the upper Thames on the western.

According to authorised published statements, the New River and East London Waterworks Companies have supplied, from the River Lea and from wells sunk into the chalk, nearly forty millions of gallons daily during the last dry summer; and under a strict conservancy of the Lea, they may continue to supply that quantity in a pure state instead of that in which it is at present. This quantity may, in fact, be regarded as a minimum, if storage, for compensation simply, be resorted to, and all sewage excluded from the river above the points of abstraction.

By extending the system of storage to the collection of surplus water for *direct* service, the supply may be increased to a very much larger amount. There is capability of storing water below Field's Weir, where the Lea and Stort join; and from this point upwards to Hatfield, on the Lea, and Bishop-Stortford, on the Stort, the sewage could be effectually intercepted.

Under a like exercise of conservancy and storage, there is no doubt that the other tributaries of the lower Thames may be made to contribute their quota. They consist of the Yedding, Brent, Roding, Hog's Mill Stream, Wandle, Ravensbourne, and Darent.

Of the Wandle and the Darent, we have the opinion of Telford and Vetch, who have pointed out their capabilities of supply. Telford proposed to take seven millions of gallons daily* from the Wandle, and in the same report proposed to take sixteen millions from the Colne. Capt. Vetch proposed to take upwards of fifty millions from the three rivers, Darent, Colne, and Mole. All these rivers have remained untried. In the meantime, the Kent Waterworks Company have shown that more than five millions of gallons daily may be and are obtained from Artesian wells sunk into the chalk, and the Essex Pure Water Company are advertising "several millions of gallons daily" from the chalk springs at Grays.

I do not offer these figures as any positive evidence of quantity, but they cannot fail to impress all disinterested persons that we possess in the rivers and springs flowing from the chalk, a valuable property within our own watershed which is by no means exhausted by the fifty millions of gallons supplied daily by the New River, East London, Kent, and Essex pure Water Companies. The storage capabilities of the chalk streams are great, when compared with the actual requirements of the popu-

lation they would serve. For example: while the minimum daily flow of the Lea, at Field's Weir, during the driest month in a dry year (1851), in which the rainfall was 22·62, was about forty millions of gallons, the maximum, *in the same month* (October), was upwards of seventy-two millions*; and the several streams rising in the chalk are all affected in like manner.

But I will confine my observations to *the tributaries of the Upper Thames* on the western side of London, rising for the most part in the oolite.

The quantity at present supplied to the metropolis from the Thames, at Hampton, does not reach sixty millions of gallons daily. This will gradually increase, and it will not be many years before we shall require eighty millions of gallons, or more. To arrive, however, at the quantity of water for which provision must be made from the upper tributaries, we must have equal regard to the towns and villages dependent upon them as to the metropolis itself, and the whole supply should be viewed as one measure.

The population of these towns and villages was, by the last census, 179,884, and to supply this number of people with thirty gallons each will require 5,396,520 daily. This consideration will increase the present quantity to sixty-five, and the total future provision to, say 90 millions, to be obtained from the upper Thames.

The area of land surface tributary to the Thames above Hampton is 2,352,640 acres; the average annual rainfall is slightly under 26 inches and the minimum 20 inches. As the total quantity of water required in the year for the population dependent on the upper Thames and its tributaries is 23,725 millions of gallons (*i. e.*, sixty-five millions multiplied by 365 days), it follows that *less than half an inch of rainfall over the whole area*, or less than one-fortieth part of the minimum rainfall, will suffice to meet the present requirement.

It remains to be seen how the Thames Conservancy Board will help to secure to their constituency this apparently small proportion in a pure condition.

Before speaking of the means which may be adopted to collect and store surplus water, I will state some of the means by which the water at command may be economised, and a considerable portion rendered available for storage.

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* *See* Beardmore's Manual of Hydrology, page 151.

1st. It has been proved that large quantities of water, rising as springs and flowing as tributaries of the Thames, are lost by absorption as they pass over the beds of free soil, forming the outcrop of the water-bearing strata of the oolite; and it is believed that water once disappearing from these surfaces, and passing underground by the dip of the strata eastward, does not again reappear within the London basin unless thrown out by a fault, and that having soon obtained a great depth below the covering strata, is lost for all possible use. This loss, in the aggregate, is very great. Mr. Simpson's gaugings of one of the Thames tributaries (the Churn), in 1859, discovered that three millions daily were lost in the course of that river by absorption, and the attendant facts go some way to show that the absorbed water is entirely lost to the river.* Every effort should be made to

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* Mr. John Taylor stated, that a survey of the River Churn, one of the principal tributaries of the Upper Thames, had been made under the direction of Mr. Simpson (Past President Inst. C.E.), in the *dry period of the autumn of* 1859. The gaugings of the volume of water, and other particulars then obtained, showed some extraordinary circumstances with reference to the loss of water by percolation through the bed of the River and the Fish and Mill Ponds upon it. The flow from the Seven Wells (the springs forming the source of the river in the Cotswold Hills) was ascertained to be 11 cubic feet per minute. At one-eighth of a mile below this point, the quantity had increased to 21 cubic feet per minute, and thence the increase continued, somewhat in proportion to the drainage area, as would be seen by the following Table:—

At ½ mile below the springs the flow was				31	cubic feet per minute.
¾	”	”	”	61	”
1	”	”	”	73	”
2	”	”	”	105	”
2½	”	”	”	165	”
4¾	”	”	”	312	”
5½ (estimated as the maximum)				320	”

At this point, however, the volume of the river, instead of increasing, began to diminish, for,

At 6½ miles from the spring the flow had decreased to				290	cubic feet per minute.
7	”	”	”	235	”
7⅜	”	”	”	179	”
8⅛	”	”	”	113	”
8⅞	”	”	”	45	”
9¾	”	”	”	33	”
12½	”	”	”	30	”

and at 14¼ miles the quantity had actually become reduced to 10 cubic feet per minute or less than the original flow of the Seven Wells. From thence to the junction of the river with the Thames at Cricklade, 22 miles from the source, the flow again gradually increased up to 110 cubic feet per minute. Thus, in a length of less than 8 miles of the course of this river, there was a measured loss of 300 cubic feet of water per minute, or 2,700,000 gallons per day. But even this was less than the actual loss, as, of course the stream would continue, under ordinary circumstances, to increase in proportion to the drainage ground, and allowing for this, the estimated flow at Cricklade ought to have been 450 cubic feet per minute, instead of being 110 cubic feet as gauged, thus showing a loss to the mills on the lower parts of the stream of 340 cubic feet per minute, or upwards of 3,000,000 gallons per day.—*Transactions of the Institution of Civil Engineers.*

prevent this, or to recover the loss by pumping before it passes out of reach. At Thames Head, three millions of gallons are already pumped out of the Thames basin and thrown into that of the Severn;* and there can be no doubt that, by multiplying the pumps at points distant from each other, a much larger supply may be obtained.

2nd. Again, in making due provision for the drainage of the clay land districts within the watershed, and in controlling the manner in which the drainage of the wide flats on each side of the river and tributaries should discharge into them, a large addition of perennial water may be gained. Under-drainage as a means of discharging water, which would otherwise be evaporated, is, in itself, a means of augmentation, and under proper control, in connection with storage reservoirs, may become a means of reducing floods, and of rendering the river flow both more copious and more regular. At present we only seek to get rid of drainage and surface waters as quickly as possible, by clearing away impediments of outfall, and thus the detention of the rainfall in passing through the drained soil is more than counterbalanced, and the rivers rise more suddenly than before. Storage would correct this in a great measure.

A glance at the accompanying map will satisfy the observer that at least one million of acres out of the three millions constituting the whole Thames Basin, are of a character to require under-drainage, if not already drained, and that from such an extent water will be discharged into the valleys during the winter after drainage, which before rested on the surface for want of outfall until it was evaporated. This extent of drainage it may take fifty years and more to accomplish, but no one doubts that the whole will be done, and that we are experiencing the effects of that which has been already done. The mean acreage-discharge of land when under-drained, has been found to be not less than three inches over the whole drained surface, and for obvious reasons we should not allow this water to run to waste at a period of the year when water is everywhere in excess, and the demand is at its least. Three inches of water discharged over a million of acres if utilized, would in itself yield a supply three times in amount the quantity now taken from the river at Hampton, and if it be the fact—as it is believed to be—that one hundred and eighty thousand acres have already been systematically under-drained within the Thames Basin, there has already been placed at disposal from this source alone more than half the quantity

* *See* evidence given by Mr. Taunton before the Rivers Commission. Page 234.

required.* But this addition to the river supply is now allowed to swell the floods in winter instead of being preserved by storage for use or compensation in summer.

3rd. The proportion of the rainfall which, rising as springs, supports the whole river system of the upper Thames, independently of storm water, has been variously taken. If, however, three inches, or about one-eighth of the rainfall be taken as the perennial supply, five hundred and sixty millions of gallons, flowing over Teddington Weir, becomes the mean or standard volume of the main river at that spot, from which nothing can be taken without reducing its natural service. The number of days in which the flow of the river is reduced below this mean may be taken at 100, and the remaining 265 days of the year will exhibit a surplus. The smallest quantity that has been known to pass over Teddington Weir has been variously stated at from three hundred millions to four hundred millions of gallons per diem. Taking, however, one hundred millions to be the mean daily deficiency of the 100 days, ten thousand millions of gallons will be the surplus of the perennial supply spread over the remainder of the year, which now goes to increase floods, and which would be available for direct supply to the metropolis, or for compensation, if stored. Were this portion of the perennial flow so turned to account we should gain a body of water sufficient to supply twenty-eight millions of gallons per diem throughout the year, or the full quantity of eighty-five millions for one-third of the year.

Storage for compensation and supply.

The Thames and its tributaries are especially rivers of floods, and a single inch of rain falling in a day has been known to nearly double its volume when at its standard height.

The proportion of the rainfall discharged annually to the sea by floods cannot be stated, but the minimum can hardly be less than three inches, or the quantity that has been represented as the *perennial* supply of the Upper Thames. This surplus alone will therefore amount to seven times the quantity required for metropolitan supply.

* During the last dry summer (1866), the town of Nantwich, in Cheshire, was relieved from scarcity by the timely appropriation of the water of under-drainage from the Combermere Estate; the ordinary supply of the town had failed, and the newly created discharge being found to be constant, a permanent arrangement has been made to secure it.

It is difficult to state to what extent the storage of surplus waters may not be beneficially applied. It may be resorted to as a means of compensating the streams for pure water taken from them, as well as for direct supply.

There are features in the Thames Basin which would materially assist the conservation of flood water for both purposes, and its delivery to the river at points where compensation will be required. I refer to the existence of impervious soils in many of the higher valleys, in which reservoirs can be constructed, to the existence of superior water at the sources, well dispersed round the whole watershed, and to the existence of canals which run alongside several of the principal tributaries, and which may serve as conduits, to convey compensation water from storage reservoirs to the river. The Oxford Canal, the Wilts and Berks Canal, and the Kennet and Avon Canal, answer this description, and may be each made a means of maintaining the supply of the main river if connected with a system of storage.

Knowing the great difficulty of constructing reservoirs in a district in which the soil and substrata vary as much as in the Thames Basin, I am glad to state the opinion of Sir John Rennie to be, that all difficulties on this head may be readily overcome.*

As already intimated, the reservoirs which would be con-

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* The following is a copy of a letter addressed to me by Sir John Rennie:—

23rd October, 1866, *London*.

DEAR SIR,—I have read with much pleasure your letter of the 15th instant to the *Times* on Water Supply, wherein you advocate doctrines a good deal similar to those which I have done for many years past, particularly as regards compensating reservoirs in the valleys through which rivers pass, and preventing the sewage matter from being discharged into the rivers.

These reservoirs would receive and store water during the periods of rainfall, and would give an ample supply of good water for domestic purposes, and would materially assist in keeping the channels of the rivers in good condition during the dry seasons.

About three years ago, I think in December and February, 1862–63, I wrote two long letters to the *Times* explaining the whole subject.

According to the present system our rivers are polluted and in a great measure destroyed, domestic water supply becomes daily more difficult, and the water itself unfit for use, and a vast quantity of most valuable manure is thrown away.

This subject is of paramount social importance, and has been too long neglected. The evil is daily increasing, and if not remedied without delay, which I contend it may be, it will assume the most fearful consequences.

It behoves, therefore, everyone to exert himself in order that the most effectual and speedy remedy may be applied, and in this good work I shall be most happy to co-operate.

I am, very sincerely,
JOHN RENNIE.

To BAILEY DENTON, Esq.,
22, *Whitehall Place*.

structed, would partake of two characters;—those for the collection of surface water for direct use, of capacity and depth favourable for purity, and those for the collection of flood waters for compensation only. The former would be constructed in those lateral valleys where soil, shape, and height are favourable for the purpose. In some instances the latter too may be made in like situations, within easy reach of the rivers or canals. In other cases they may be made by widening and embanking the river courses, for a length and breadth sufficient to retain an equivalent for the pure water abstracted for domestic supply immediately above. As in the matter of compensation quantity is an object of more importance than quality, depth of storage is not of so much moment as the collection of surplus water in the readiest and cheapest way. This may frequently be accomplished by widening and raising a mill head, and converting it into a reservoir of 200 or 300 acres in extent.

To make this point clear, let it be assumed that one of the many mills on each of the higher tributaries marks the line of demarcation where the sewage from above may be intercepted, and that into the tail of this mill the intercepted sewage may be discharged. This mill should be purchased, and the tail water, forming the head of the next lower mill, would be widened and embanked to the extent required. The reservoir would be formed by excavating the soil on each side to the depth of the river, and by raising the water within banks above the surface. It would receive all the surface and surplus water to be collected from the upper portion of the valley, and would be refilled as succeeding floods or flushes brought down a fresh surplus.

The river itself would pass through it, and any water abstracted above would be compensated from the reservoir.

The extent of storage room that would be necessary to accomplish the system here pointed out would be 1,000 acres, of a mean depth of 20 feet, for the collection of water for *direct* supply; and 2,000 acres of a mean depth of 10 feet, for compensation.

Description of proposed Works.

The head of the proposed works would be the fork formed by the Thames and Severn Canal (extending from its summit at Thames Head to its junction with the Thames at Lechlade) and the North Wilts Canal. It will be remembered that, during the last Session of Parliament, the Thames and Severn Canal Company sought powers to convert their canal into a Railway. It was then stated and admitted that the canal was not in a profitable condition. It

would be necessary to purchase these canals, and, by rebottoming, convert them into impervious conduits for the collection of pure water from the upper portions of the Churn, the Swill Brook, and the River Ray, and of such additional water as may be obtained by the restoration of the three millions of gallons which now runs into the Severn, as well as by additional pumping at spots, distant from each other, along the line of oolitic outcrop, whereby a considerably increased amount may be gained, which would otherwise be lost. Reservoirs would be made in the way I have suggested, along the course of the three streams named, to afford compensation for the water abstracted from them.

From Lechlade to the meadows just below Oxford, (where it would be desirable to have a supply reservoir,) a channel would be formed following the course of the Thames—paved with concrete and embanked so as to allow of the utmost cleanliness and prevent the influx of surface drainage and flood water—which would act as a receiving conduit for the pure water to be furnished by the several tributaries which it will cross and meet on its way.

The tributaries that would be crossed and met would be the Ampney Brook, the river Colne, the river Cole, the river Leach, the river Windrush, the river Evenlode, with the river Glynne, and the several minor streams which join the Thames above Oxford. At Oxford the receiving main would join the supply to be gained from the Cherwell and branches above the point of pollution, as well as by storage in reservoirs formed in the higher lateral valleys for direct supply. From the supply reservoir at Oxford, another paved conduit would convey the water by Abingdon to a point near Wallingford, having received contributions of supply from the Ock and the Thame. From thence to Hampton the water thus collected would be delivered to the Water Companies' Works by a *covered* channel, having received in its course the contribution of the Kennet River, the Lodden, the Colne, and certain springs rising near the main river, making up in the whole a supply of eighty millions of gallons daily. Oxford, Abingdon, Wallingford, Reading, Windsor, and the towns and villages on the banks of the rivers would have been previously supplied from the conduit as it passes by them to the amount of upwards of five millions of gallons daily.

The open conduit from its commencement at Lechlade to Wallingford would be of a semicircular form. It would increase in dimensions as the tributaries added their quota to the volume.

The covered duct would be eight feet deep by ten feet wide. The mean fall would be nearly twenty inches per mile.

From Lechlade to the Meadows near Oxford the distance is	29 miles, and the fall	48 ft. 6 in.
From this point to a point above Wallingford, the distance is	23 „ „	40 ft. 6 in.
From thence to Hampton, the distance is .	75 „ „	121 ft. 6 in.
Total length	127 miles.	Fall 210 ft. 6 in.

These works on the upper Thames would be extended to the necessary conduits connecting the unpolluted portions of the tributaries with the receiving main, and would include the construction of reservoirs, the purchase of the special mills affected, and compensation to landowners, &c.

On the Lea, of the lower Thames, a similar, though reduced system of works would be carried out.

The cost of the whole may be estimated at £4,500,000, including interest on money expended and attendant expenses.

To place the present project, however, on the same footing as those which are designed to take their supply from the mountain ranges of Wales and Cumberland, it is right to state that the promoters of these distant schemes propose to deliver their supply at a height sufficient to command a high and constant service for nearly the whole of the metropolis, whereas, in the present instance, it is simply intended to deliver the water collected to the existing Companies and leave it to them, or a central body, to distribute, with the *existing* machinery and appliances.

Against the annual cost of lifting the supply to existing reservoirs, the expense of rearranging the whole system of service piping will form no inconsiderable set off.

Though the advantageous effect of these works would be coextensive with the whole system of the Thames, their multiform character will subject them to the adverse remarks of those who advocate undertakings of more imposing dimensions.

Englishmen have not been unfrequently twitted by reference to the grander works of other countries, and those of ancient times have been pointed out as examples for Engineers to follow. The aqueducts of Rome—the Aqua Virgo, the Aqua Alsietina, and the Aqua Claudia, and the more colossal remains of the Anio Novus—have been pointed out, and illustrating, as they do, good judgment in selecting the pure water of fourteen different springs, in preference to the polluted waters of main channels, they are especially deserving the attention of modern municipal authorities.

But, as works of engineering, these conduits being carried high in mid air over the hot plains of the *campagna*, display a want of hydraulic and sanitary knowledge, which we should avoid rather than copy. In fact, when we study the famous Cloacinæ, which it is believed drained the city upon which Rome itself was built, and associate that work with the aqueducts, which for upwards of two thousand years have traversed, like so many stilted centipedes, the *Campo Romano*, we cannot fail to condemn the want of judgment by which they were executed, though impressed with the soundness of the objects for which they were designed. It is indeed remarkable that in both drainage and water supply the ancients acted upon the very principle which we are now making the greatest efforts to establish, viz.:—that both objects should be carried out together, though the service of each should be kept perfectly distinct. In ancient Rome, too, different qualities of water were used for different purposes. The baths of Caracalla and Diocletian were served by *aquæ* distinct from the fountains of public places and the *pozzo* of private houses.

Upon the important question of abstracting the waters of one district for the purpose of supplying another, I feel sure I shall have your Lordship's serious attention. When once it is acknowledged that large towns may take from neighbouring or distant valleys the water they require, without making every effort to develop the resources of the valleys in which they themselves exist, it will be impossible to say where the mischief may end.

By two of the projects now presented to the metropolis for adoption, it is proposed to bring water from the north-western part of the Kingdom—the first being from the sources of the Severn, and the other from the lakes of Cumberland. The latter will pass to the south of the manufacturing districts of which Lancashire is the centre, and the other will pass directly through those districts.

Your Lordship is, no doubt, familiar with the fact, that nearly every town between Lancaster on the north and Birmingham to the south, and between Liverpool on the west and Hull on the east, has been suffering from a deficient supply of water during the late dry summers; and it may serve to make the injustice of robbing one district to satisfy another more apparent, if I quote some statistics which predicate a future condition in this great nucleus of commerce demanding a more abundant supply of water than can ever be required in the metropolis itself.

The population of Lancashire has trebled itself in fifty years. In 1811 it numbered 828,499, and in the last census of 1861 it has increased to 2,429,440. In Liverpool the increase of population has been 539 per cent. in sixty years, and in Manchester 484 per cent. The annual value of property in the county has increased from 3,087,774, in 1815, to 11,453,851 in 1865; while the increase of annual income, as shown by the property and income tax returns, has been after the rate of 570 per cent. in the same period. Of all the factories in England, 80 per cent. is claimed by Lancashire alone.

Now these startling figures refer to Lancashire only. In the neighbouring counties of Yorkshire and Cheshire, a surprising increase of population and trade has also taken place, though not in the same ratio; and it is to be anticipated that, in fifty years hence, the concentration of commerce located in South Yorkshire, Lancashire, and Cheshire, will very far surpass the proportion it now bears to the rest of the kingdom. The population of London and the home counties will be secondary, when compared with that of these important districts. And when such is the case, it will be a source of considerable national satisfaction that the neighbouring high grounds of North Wales and Westmoreland, with the rainfall which distinguishes them, will be capable of meeting the increasing demand for water without which our manufactures could not be maintained in their increasing importance. Moreover coal will, to say the least, become more costly as it becomes more difficult to procure, and water will then be valued more highly than at present as an agent of motive power. This use of water, however, though most important, need not be named to command your Lordship's attention to the main question of providing for present necessities, with a due regard to future demands, and of considering the requirements of the country generally, when dealing with large towns.

The whole question is, in truth, one of the greatest national importance. The less populous any town or village may be, the less able it is to take care of itself against the inroads of larger places and the more it requires the protection of the Government. On these grounds I commend the whole subject to your Lordship's consideration.

Separate services of water.

There may be a time when the water of the metropolis may have to be divided—as I have stated is done at Shrewsbury and was done by the ancient Romans two thousand years ago—into two descriptions of supply, viz., that which is required

for drinking and cooking, which must be perfectly pure, and that required for other purposes, which need be only clear and fresh. The utmost quantity required in the former case does not reach a gallon each person, so that three millions of gallons daily would satisfy the metropolis on this head. Thus, then, either the water now pumped up by the Thames and Severn Canal Company and thrown into the Severn, or the water lost by absorption from the river Churn in its passage over the oolitic porous outcrop, would suffice; or a nearer supply, to be obtained by Artesian wells in the chalk, or the lower green sand, would serve for the purpose better. But if the supply of perfectly pure water be extended to washing and all kitchen uses, the quantity required will probably reach three gallons each person, and then ten instead of three millions of gallons will be required. And such being the case, I would submit for the consideration of your Lordship and the country at large, whether the coming necessities of other districts should be disregarded, because it is inconvenient and costly to establish in the metropolis one service of water for the kitchen use and another for water closets, street purposes, &c. The opinions of our chemists show that the softening process can now be profitably carried out on an extensive scale (*see* Appendix), and if one service only undergoes the process, the objections hitherto raised to its general adoption fall to the ground.

J. BAILEY DENTON.

22, Whitehall Place,
Westminster,
December 28*th*, 1866.

APPENDIX.

11, Salisbury Square, Fleet Street, E.C.,
November 2nd, 1866.

Dear Sir,

In reply to the questions which you address to me in your note of the 31st October, I do not hesitate to give you distinct answers. As regards the first, I beg to say that it is possible to reduce, with certainty and economy, the hardness of large bodies of water by processes already known and acknowledged to be sufficient, not only by chemists, but likewise by railway companies, dyers, and others, who have practically adopted these softening processes on a large scale. As regards the second question, I am decidedly of opinion that it is far more easy and cheaper to reduce the hardness of water in large quantities than to make the tainted water of rivers pure enough to drink. I believe rarely any difficulty will be experienced to soften, efficiently and expeditiously, large quantities of water at a mere trifling expense, but conceive the artificial purification of river water, largely contaminated with sewage, either to be altogether impracticable, or far too expensive for all ordinary purposes for which water is used.

For these reasons I have always been a consistent advocate for keeping sewage out of our watercourses, and hope the time will not be far distant when our streams will be kept clear from this source of danger to the health of people. The sooner sewage and filth of every description is put upon the land the better, for I need not tell you the soil is the most efficacious of all practically available means of rendering offensive refuse matters harmless, and converting them into food of plants.

Believe me, dear Sir,
Yours very truly,
AUGUSTUS VOELCKER.

J. Bailey Denton, Esq.

St. Bartholomew's Hospital,
November 3rd, 1866.

Dear Sir,

I can state, in reply to your queries, that the practicability of reducing with certainty and economy the hardnesss of large

bodies of water, has been proved, beyond all question, by processes which also effect a diminution in the amount of its dissolved organic matter. On the other hand, according to our present knowledge, it is impossible, by any artificial processes, to render large bodies of sewage-contaminated water pure enough to be suitable for drinking purposes.

I am,

Yours truly,

J. Bailey Denton, Esq. WM. ODLING.

11, Salisbury Square, Fleet Street,
November 6*th*, 1866.

My dear Sir,

I have repeatedly analysed the clarified water of sewage after it has undergone the "purifying" influence of irrigation, and in the majority of instances found such purified water, though clear and free from smell, almost as unfit for drinking, cooking, or washing purposes, as it was in its original filthy condition. Many people call water pure when it is clear, and no smell perceptible, forgetting all the while that the greater proportion of the soluble alkaline medicinal salts, together with the products of oxidation of the nitrogenous constituents of fæces and urine, *cannot* be removed by filtration *through any amount of soil.* It is, no doubt, a wonderfully beneficial arrangement of the Creator to endue all soils more or less with the power of absorbing the most important fertilising constituents of excrementitious matters, and of converting injurious fœtid putrifying organic matters into comparatively harmless and inoxuous compounds, but at the same time it should be remembered that the largest proportion of the saline constituents of the urine of man and animals, together with the nitrates formed by the oxidation of urea and other nitrogenous matters pass into the clear filtered or irrigation water; and that such saline salts, more especially the nitrates, have a powerful medicinal effect.

I have analysed and tested so called sewage water, after it had undergone filtration, through soil, and found it not worse for drinking and domestic purposes than Thames water, as supplied by the Metropolitan Companies. However, such so called purified sewage could hardly be called with propriety sewage, for it had passed three or four times over land, and in its course got considerably diluted with clear and purer water. As well

might river water contaminated to some extent with sewage in a particular locality be still called sewage at a distance of forty or fifty miles, after large bodies of purer water have greatly diluted the impurities, and the purifying influence of atmospheric oxygen has operated upon them, to an extent that their presence cannot readily be detected, even by delicate chemical tests. There is of course a limit to everything, and I do not deny that sewage water, after filtration through a great mass of soil, may be rendered perfectly clear, colourless and inodorous, and afterwards by admixture with large bodies of originally purer water, may become fit for drinking; but sewage of *towns as such, cannot be rendered potable by filtration through soil.* Hence it follows incontestably that just in proportion as spring or river-water is contaminated with sewage, clear though the purified sewage may be, in that proportion it will be less fit for drinking. In conclusion, I may add, that I have examined "purified sewage," which when first received, was perfectly inodorous and colourless, after keeping for some time again became extremely offensive, and I need not add quite useless for any domestic purposes. However, supposing that town sewage could be so thoroughly deodorized and clarified as not to turn bad again, I still maintain the clearest, most inodorous and even agreeable tasting "purified sewage," unless diluted with purer water to a considerable extent, is unfit not only for drinking, but also for cooking, washing, and general domestic purposes.

Yours faithfully,

AUGUSTUS VOELCKER.

J. BAILEY DENTON, Esq.

17, SUSSEX PLACE, REGENT'S PARK,
November 8th, 1866.

DEAR SIR,

It is quite impossible for me to give a categorical answer to such an abstract general question as you have proposed, for in the first place the quality and nature of sewage differs in so wide a degree as to be itself nearly harmless, or so charged with noxious matters as to be a positive poison. In the next place, the question of irrigation may be of extreme degrees, and so also may those of filtration and chemical precipitation.

If, therefore, you put it to me whether the worst kind of sewage can be so dealt with by any reasonably practical means

as to be made at once fit for drinking purposes, I have no hesitation in saying that it cannot; but I can, on the other hand, say in quite as positive terms that ordinary sewage can be so dealt with by irrigation, precipitation, filtration, dilution, and oxydation, as to be rendered perfectly inert, and that the flow of such defœcated sewage into rivers is altogether harmless. I will go further and say, that the ordinary sewage of a town may be so defœcated by easily managed chemical processes, that when it is mixed with not less than twenty times its volume of good water in a river, and has a run of eight or ten miles, it is not merely harmless, but is actually destroyed, and the water is fit for domestic use.

Yours truly,

HY. LETHEBY.

P.S.—Don't infer from this that I advocate or would for a moment sanction the *indiscriminate* discharge of sewage into rivers.

13, MANCHESTER SQUARE, W.
December 6th, 1866.

MY DEAR SIR,

There cannot be a doubt that impure water proves an important agent in the production and dissemination of disease. In some instances its action appears to be direct and in others indirect. In the one class of cases it serves as the vehicle for introducing the poisonous germ of disease into the body; in the other it acts by deranging the stomach and bowels, lowering the tone of the system, and so rendering the body susceptible of any depressing influence to which the individual who has drunk the water may be exposed. In many cases, probably, it operates in both ways; namely, as the medium through which the poison finds entry into the body, and as the agent by which the digestive organs are disturbed and fitted for its reception and development.

I am inclined, however, to question the generally received doctrine as to the mode in which water, in most cases, becomes impregnated with the seeds of disease; especially do I doubt the prevalent opinion respecting the mode of its contamination by the germs of cholera. Many authorities assert that this is effected solely by the introduction of choleraic excreta. But this doctrine has little more than theory to support it, and it has always appeared to me that the absorption of the cholera germ from the atmosphere is a more feasible and more frequent

source of water contamination than the direct admixture of cholera excreta. It is constantly assumed, *but it has never yet been proved*, that the rice water evacuations contain the germs of cholera, and although this assumption is not improbable, it will not serve to explain many facts in the history of cholera. It offers no solution of a circumstance frequently noticed, namely, the sudden and mysterious outbreak of the disease in a district in which not a single case of cholera has previously occurred; and it is scarcely consistent with the occasional rapid disappearance of the disease from districts in which it has already raged, since the water, if tainted by excreta at the commencement of the attack, must be a hundred-fold more so during the prevalence of the epidemic. But if it be admitted that the cholera germ exists in the atmosphere, and is absorbed, as it surely would be by the water, this difficulty is at once removed, as it is simply in accordance with experience to suppose that the germs of the disease, when freshly developed, would prove more energetic in their action than they would towards the close of the epidemic, and therefore that water which at first might prove poisonous, would ultimately lose its poisonous character. I would guard myself, however, from being understood to imply that the occurrence of cholera is due exclusively or even principally to impure water. There are endless facts which prove that the atmosphere is the principal vehicle for the diffusion of the cholera poison, which may also be conveyed by contagion, or direct transmission from one person to another. But I believe that water drawn from a tainted source, or in other words, from a district in which cholera prevails, may become contaminated by the cholera poison, derived probably in part from choleraic excreta and in part from contact with the tainted atmosphere. When so contaminated, the water doubtless exercises an important influence on the spread of the disorder.

As the germs of cholera have never been isolated (for the so-called cholrine mentioned in the Registrar-General's report cannot be so regarded until its power to produce cholera has been proved), it is impossible to say what means may be requisite to ensure its removal from water which has once contained it. Direct experiment has shown that mere filtration, even through animal charcoal, fails to remove more than a portion of the organic constituents of water, and that there are certain organisms which appear even to resist the influence of boiling. The effect of running water in oxidising or otherwise destroying organic matter is very remarkable, but there are no reliable data on which to base an opinion as to the length of run

which the water requires before its organic contents are resolved into their elements, nor even as to whether certain living organic matters—such as there are good grounds for supposing the cholera germ to be—are ever destroyed or rendered innocuous by this agency. There is evidence, however, to prove that a course of some miles will not suffice to effect this object, and it is probable that in ordinary slow running streams like the Thames, many sporules and ova may retain their vitality almost indefinitely.

Practically, I cannot doubt as to the expediency of covering the reservoirs in which our water is stored, and the conduits through which it is conveyed to our dwellings. Water, when exposed to the atmosphere, may become at any moment a source of disease. Whatever care may be taken to guard it from contamination by the excreta of human beings, it is scarcely possible but that some will reach it through filtration or otherwise, and it must necessarily be exposed not only to absorb any poisonous matter which may be contained in the atmosphere, but to receive the excreta of animals, birds, fishes, and insects, from which are derived the ova of many parasites which infect the human body. It is impossible to cite a more striking evidence of this than is contained in a valuable paper by Dr. John Harley, published two years since, in the "Transactions of the Royal Medical and Chirurgical Society of London," in which it is shown that a distressing and intractable form of disease, extremely prevalent at the Cape of Good Hope, was attributable solely to the ova of an insect introduced into the human body in this manner.

I do hope that you will exert your influence, not only to obtain water for our use from a pure source, uncontaminated by sewage, but to have all reservoirs and conduits covered, so as to prevent its subsequent pollution, and insure its delivery in its pure condition.

Believe me,
My dear Sir,
Yours faithfully,
HENRY WM. FULLER, M.D., Cantab.

To J. Bailey Denton, Esq.

Vacher & Sons, Printers, 29, Parliament Street, Westminster.